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Research in Applied Mathematics
Related to Identification of Noisy Systems

Final Report

January 1988

R. E. Kalman Principal Investigator

April 1, 1985 through September 30, 1987

U. S. Army Research Office Grant Number DAAG29-85-K-0099

Center for Mathematical System Theory University of Florida

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THE VIEW, OPINIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER DOCUMENATAION.

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The grant period reported here (1985-1987) was, in many respects, a transitional one. Many of the publications listed below refer to work continued (or completed) from earlier grant periods. Two of the authors---BIRGET and EMRE---were postdoctoral fellows at the CENTER FOR MATHEMATICAL SYSTEM THEORY; their publications reflect continuing research at other universities, under support other than ARO-Durham.

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The publications of BIRGET and EMRE belong, broadly speaking, to algebraic system theory. This direction of research is still active at the Center, but the main emphasis has shifted since 1985 to the analysis and theory of systems observed via noisy data.

Since the research program for noisy analysis and noisy realization theory is only about half-way complete, the number of <u>publications</u> reporting results of this phase of the grant are, at the moment, rather limited. (There are a number of internal unpublished lecture notes which are not available for general distribution.) See, however, two papers by the Principal Investigator, KALMAN [1985, 1987], which present the organizing ideas of the current investigation.

An extensive amount of data analysis by computer was performed during the past two years, supplementing spot-checks in 1981-1984 on real data (for example, the published data on the so-called Tintner meat-market problem). These previous data analyses were important in

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showing that new research is needed. The empirical analysis of real data is related to the present build-up of the Center's own computer facilities and serves as a check on the programs being developed.

The results of the theoretical and computer investigations on the identification of static systems (linear relations) will appear soon in the research monograph KALMAN [1988] that has been in preparation for several years. There is a great deal of confusion in the literature about what the scientific issues of identification are. A coherent presentation of the results is almost impossible without a certain amount of tutorial material. The objective of the monograph KALMAN [1988] is not only to explain the facts of life but also to enable the reader to duplicate the quite sophisticated data analysis procedures which we have developed. In short, the objective of the monograph is not polemical but tutorial.

As soon as the Center computer facilities are fully operational and tested, we would be very interested in looking at real-data problems of Army Research Laboratories, not only to help them but to explore the potential breadth and applicability of the new methods.

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# R. E. KALMAN

- [1987] "The problem of prejudice in scientific modeling", (to appear).
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#### J. C. BIRGET

[1986]	"Stability and j-depth of expansions", accepted by
	Bulletin of Australian Mathematical Society.

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- [1987] "Concatenation of inputs in a two-way automaton", 24 pages, submitted to Theoretical Computer Science.
- [1987] "Two-way automaton computations", 34 pages, submitted to RAIRO, Informatique Theorique.

#### E. EMRE and J. H. SEO

- [1987] "A realization theoretic solution of two analytic matrix equations with application to stabilization of infinite dimensional systems", November 1986, 20 pages, to appear in the Proceedings of the International Symposium of Mathematical Theory Networks and Systems, Arizona, 1987.
- [1987] "A realization theoretic solution of two analytic matrix equations with application to stabilization of infinite dimensional systems", 33 pages, submitted to IEEE Transactions on Automatic Control.

### E. EMRE, H. TAI, and J. H. SEO

- [1987] "Transfer matrices, polynomial fractions and realization of continuous-time linear time-varying systems", 10 pages, to appear in Proceedings of the Allerton Conference, October 1987.
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#### J. HAMMER

[1987] "Assignment of dynamics for nonlinear recursive feedback systems", 41 pages, to appear in the Journal of Control.

### PERSONNEL SUPPORTED UNDER THE CRANT

### (a) Regular Personnel

Dr. R. E. Kalman, Principal Investigator

### (b) Visitors

## Short-term visitors for 1985/87

Dr. A. Lindenmayer, University of Utrecht, THE NETHERLANDS

Dr. Y. Rouchaleau, (now of Ecole Nationale Superieure des Mines de Paris, FRANCE)

Dr. J. Waldvogel, University of South Florida, Tampa, FL

## Long-term visitors for 1985/87 (one month or more)

Dr. J.-C. Birget, (now on faculty of University of Nebraska)

Dr. E. Emre, (now on faculty of Texas Technical University)